

Episode Selection

Attachment 1 to Phase I of the Mid Course Review

**Technical Support Section
Technical Analysis Division
TCEQ**

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Mid Course Review Process

On December 6, 2000, TNRCC adopted rules designed to help bring the Houston/Galveston (HG) non-attainment area into compliance with the health based, 1-hour standard for ozone. The TCEQ has committed to complete a mid-course review to evaluate progress toward attainment. The mid-course review will require a revision to the State Implementation Plan which will be submitted to the EPA in 2004. The mid course review will evaluate progress made, and assess the need for mid-course corrections to ensure the HG area will be in compliance with the 1-hour standard in 2007.

The Texas 2000 field study collected extensive data during the August 15-September 15, 2000 period and increased the number of well monitored periods of elevated ozone available for modeling in the HG domain. Aircraft measurements of ozone, NO_x, VOCs and formaldehyde added considerable insight to ozone formation in the Houston area. The TexAQS study captured “classic” sea breeze driven ozone events as well as several less common ozone events involving a variety of wind directions.

In January 2001 the Houston/Galveston Technical Review committee reviewed the Conceptual Model for Ozone Formation in the Houston-Galveston area based upon the data available at the time and recommended three episodes for mid-course modeling. Candidate episodes from the 1998-2000 period were selected in order to reflect the current design value and current emissions as well as allowing the incorporation of improved monitoring data. The committee evaluated ozone episodes based upon their ability to represent the most frequent and typical patterns associated with high ozone in the Houston/Galveston area (HG). The committee recommended modeling a primary episode to represent typical ozone conditions and two supplementary episodes to address additional issues.

- August 1-5, 1998
- August 26-30, 1998
- August 25- September 1, 2000

The August 25-September 1, 2000 TexAQs episode was selected as the primary episode because it had numerous exceedances in both Houston and Beaumont, including sea breeze flow reversal and representative transport level wind directions. The August 25-Sept 1 episode also occurred during the Summer 2000 Texas Air Quality study so it allowed access to all the special meteorological and air quality measurements made during the period. The two August 1998 episodes were recommended because they also had numerous exceedances, flow reversal and high monitored ozone in areas not represented in the Aug 25-Sept 1, 2000 episode.

Recent Revisions to Episode Selection Recommendations

Analysis of recently received TexAQS data suggests that the TexAQS 2000 study period includes the types of episodes found in the 1998 supplementary episodes. Since the TexAQS study includes more monitors, extra instrumentation and aircraft data, the commission believes it is advisable to discontinue consideration of the two 1998 episodes, and instead extend the TexAQS episode window to include the episode types not included in the initially defined TexAQS 2000 period for modeling. The Phase I modeling included in the current SIP revision (December 2002) is limited to the August 25-Sept 1, 2000 episode, but in the Phase II modeling, additional days before and after the initially modeled episode will likely be included in the modeling.

The TexAQS 2000 data has been quality assured, peer reviewed and shared among the numerous scientists who participated in the study. As a result of that analysis a more comprehensive conceptual model has been developed for ozone formation in Houston, found in Attachment 2 to this document. It is now clear that the Ship Channel industrial sources of VOC and NO_x are a major factor in the high ozone measured in the Houston area. Depending upon the daily meteorology (wind direction and time of stagnation/flow reversal), precursors from the industrial sources accumulate in a pool and are transported across the city. The transport of these pools of ozone account for both the rapid rise in ozone and the short duration of the peaks measured at Houston monitors.

Wind Direction Analysis for Phase I Episode Selection.

Previous work on episode selection is documented in the February 28, 1998 TNRCC Attainment Demonstration for the Houston/Galveston Ozone Nonattainment Area Revisions to the State Implementation Plan, specifically in Appendix A, Volume I which discusses Episode Selection and Meteorology. Table 2-2 of that document evaluates the predominant wind directions associated with ozone >180 ppb during the 1990-1994 period.

- The most frequent morning wind category in that analysis was “Calm” (light and variable, for winds <1.5 m), comprising 35% of the events. (Wind direction is not determined for very low wind speeds.) Another 12% of the events were associated with morning winds from the west-northwest.
- The most frequent afternoon wind categories were winds blowing from the east-southeast and the south-southeast, representing 36% of the events. These two wind directions are roughly perpendicular to the coastline in the area and represent the winds during the afternoon sea breeze. Afternoon “Calm” winds were associated with another 14% of the ozone events.

The method used in the February 1998 analysis tends to underestimate the wind speeds since it averages the u and v components of the wind over the domain, and then combines the averages into a composite vector. So, the method tends to allocate too many events to the “Calm” category. Nevertheless, the overall conclusions of that analysis agree with the recent Conceptual Analysis in Attachment 2, which identifies calm or light west-northwest winds in the morning, combined with southeasterly sea breeze winds in the afternoon (the Houston/Galveston “Classic” ozone event).

TexAQS Phase I Ozone Episode

The table below summarizes the data from the TexAQS episode period selected for Phase I modeling. Bold numbers indicate exceedances of the 1-hour standard measured at surface monitors and days with numerous exceedances.

Date	Day	Sfc Winds	Weather	Sfc Max O3	Max Location	# Sites Exceeding
23 Aug*	Wed	SE/East	Cldy/Rash	101	Bayland	0
24 Aug*	Thurs	SE/ESE	Cldy/Rash	111	La Porte	0
25 Aug**	Friday	East	Clear	194	Crawford	12
26 Aug	Sat	SE	Clear	140	Conroe	1
27 Aug	Sun	SE	Clear	87	Conroe	0
28 Aug	Mon	SE	Clear	112	Conroe	0
29 Aug	Tues	South	Clear	146	Mt Bellvue	3
30 Aug	Wed	Loop	Clear	199	La Porte	7
31 Aug	Thurs	Loop	Tstms	168	Deer Park	10
01 Sep	Friday	SW	Tstms	163	Baytown	2
* Ramp up days ** “Classic” sea breeze flow reversal day Rash = rainshowers						

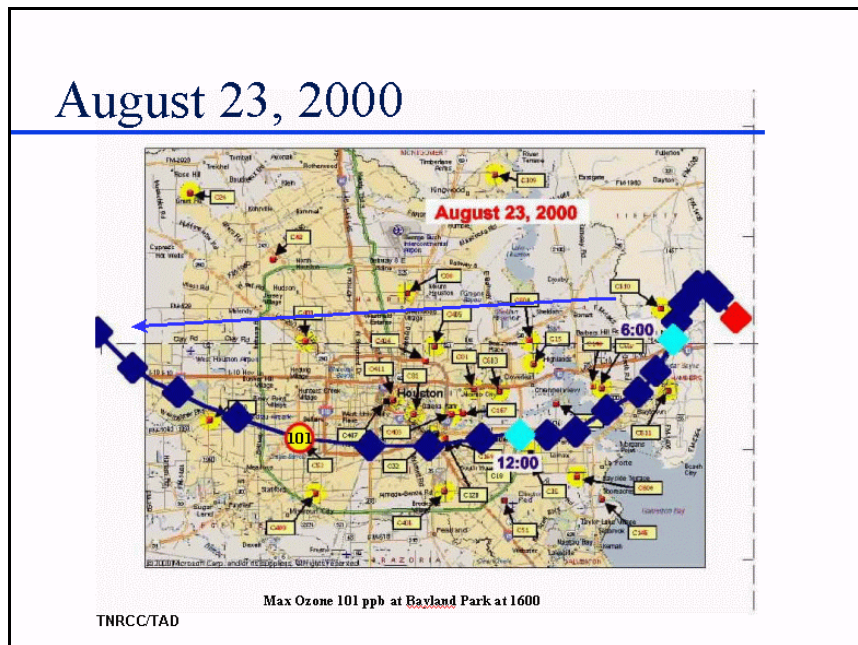
Winds during the August 23-September 1 TexAQS period include not only Houston/Galveston “Classic” ozone events, but an orderly clockwise progression in the net surface transport vector each day during the period. The August 24th, 25th and 26th ozone days represent variations on the “Classic” ozone event, with August 25th being the most typical.

The TexAQS Phase I episode includes a 10-day window with both weekday and weekend events, a suite of wind directions, and daily ozone peaks measured in several different areas of the city reflecting the net surface transport during each day. When combined with the extraordinary amount of meteorological and precursor data collected during the TexAQS study period, this extended ozone episode includes a well monitored and representative mix of Houston episode types.

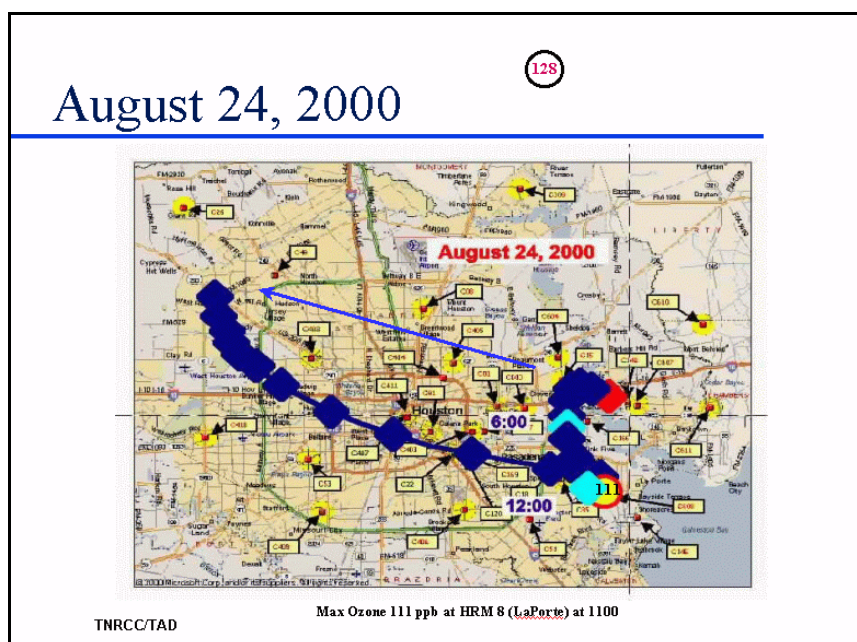
The next section of this document includes maps and discussion of each day during the TexAQS Phase I Ozone Episode.

Ramp Up Days

During the two ramp up days, August 23 and 24th, aside from a brief period of morning stagnation the winds are relatively persistent coming from the east. The flow pattern appears to carry the industrial emissions west and northwest of the city into unmonitored areas on both days. However, on August 23, Williams Tower reported 149 ppb of ozone.

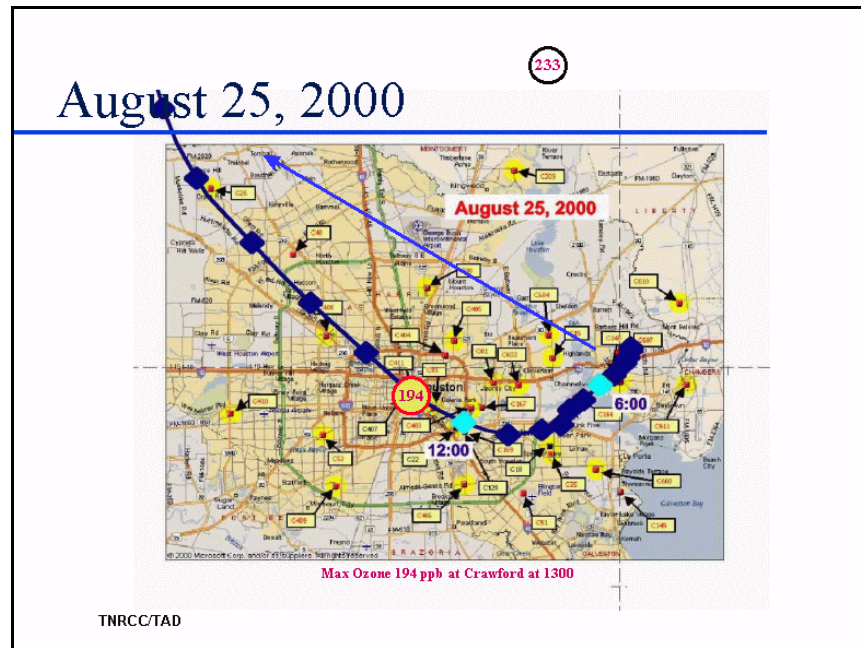


August 24th has a “Classic” morning/afternoon wind pattern, but the afternoon wind appears to carry pollutants across the monitoring network and out of town. However, aircraft measurements that day indicated that ozone as high as 128 ppb occurred downwind of the city.

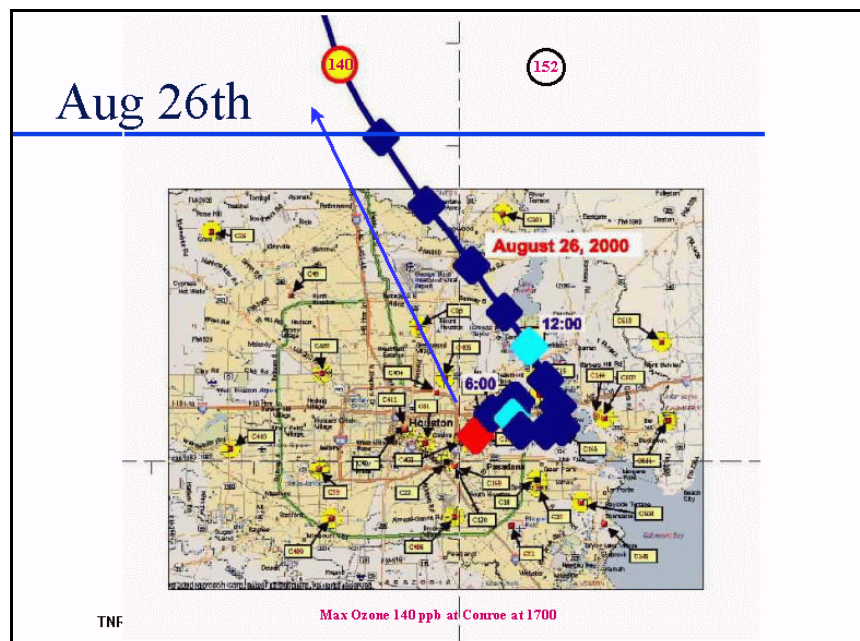


August 25th and 26th , 2000

August 25th and 26th represent the Houston 'Classic' flow pattern with calm or light morning winds followed by the afternoon sea breeze. On the 25th, morning surface winds are light from the northeast, and then shift with the afternoon sea breeze, carrying the industrial emissions across the city and the monitoring network. Monitors measured 194 ppb at Crawford and 11 additional exceedances at other sites that day. Aircraft measurements on August 25th indicated ozone as high as 233 ppb downwind of the urban area.

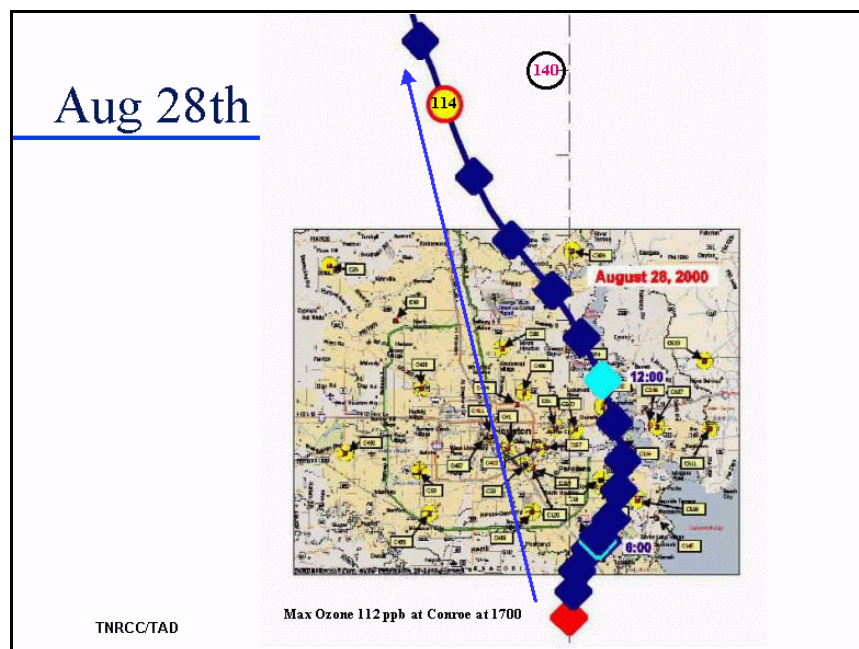
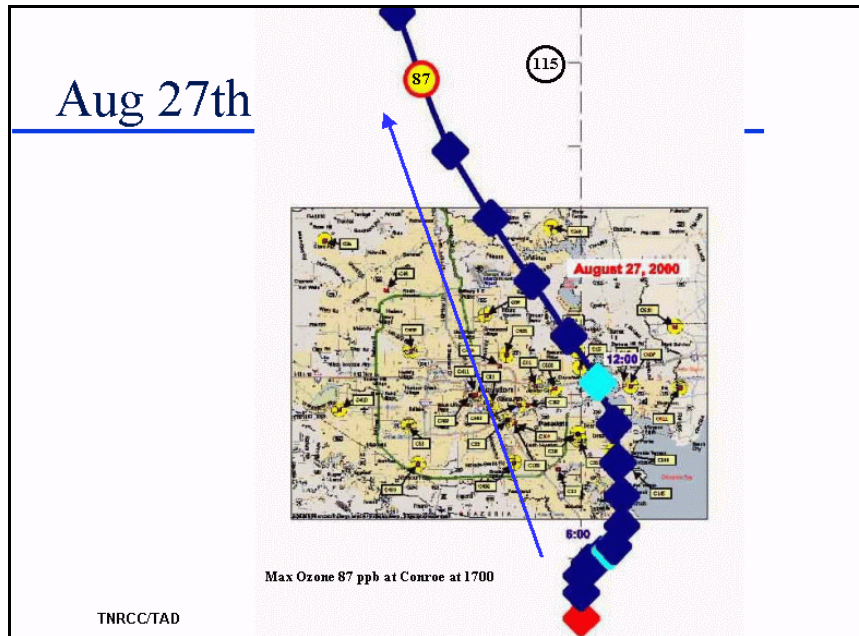


On August 26th the morning wind flow was nearly calm, coming from the south and stagnating over the Ship Channel. The afternoon sea breeze flow carried the industrial emissions north toward Conroe, which measured the only exceedance that day. Aircraft measurements on Aug 26th indicated 152 ppb of ozone east of Conroe.

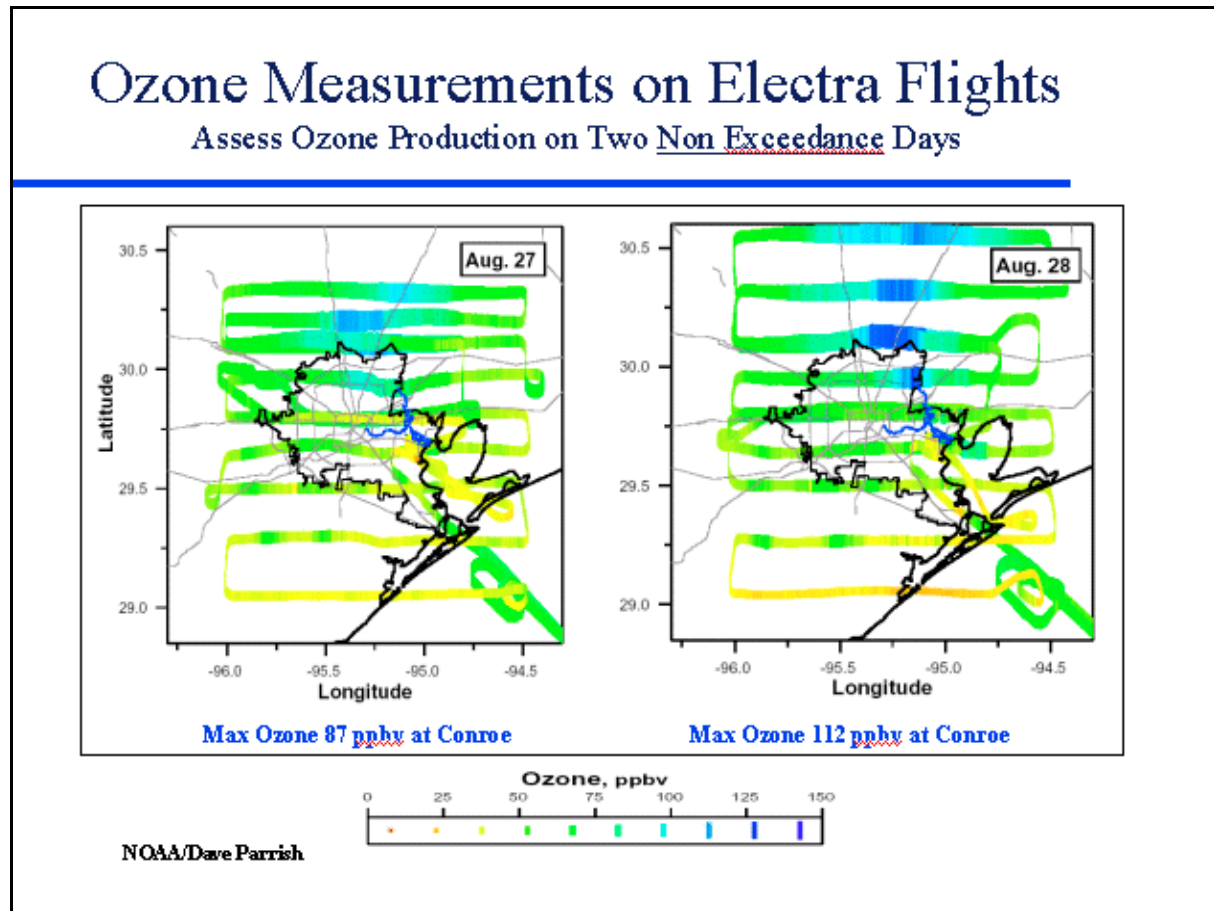


August 27th and 28th

August 27th and 28th provide an interesting contrast to the “Classic” flow reversal days. The winds on both of these days were fairly persistent, coming from the south in the morning, not pausing over the industrial area, and carrying the pollutants north toward Conroe which measured the highest ozone in the area. No exceedances at the surface. Preliminary assessments suggested that the relatively strong and persistent winds were responsible for the low ozone measured at the surface on those days.



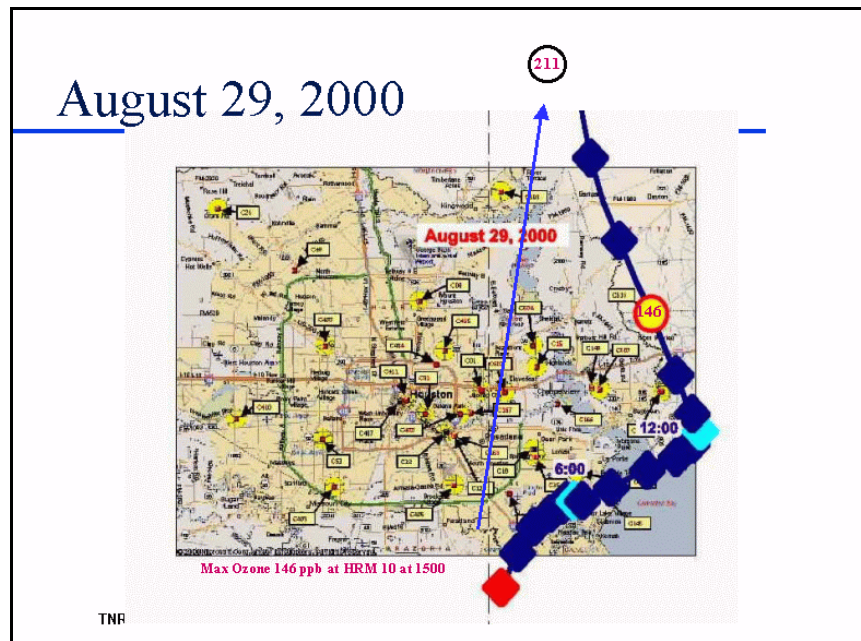
However, aircraft measurements made on both the 27th and 28th show a plume of ozone coming from the industrial area ship channel and extending north of the city, into areas without surface monitors. Aircraft measurements of peak ozone in the plume on those days were 115 and 140 ppb. So, contrary to the early assessment, these two days do have elevated ozone, higher than measured at the surface, and can be used to characterize the urban and industrial plumes coming from Houston. The aircraft data also suggests that ozone may be occurring more frequently and in



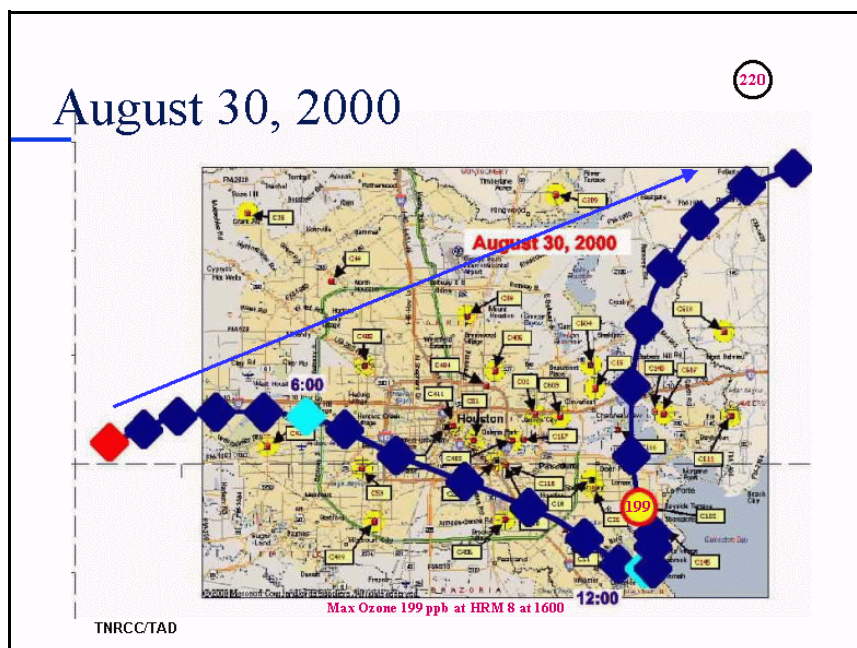
more areas than indicated by the surface monitoring network.

Aug 29th and 30th, 2000

On August 29, morning winds came from the southwest, and then shifted to the southeast at noontime with the sea breeze. The peak ozone measured at the surface was 146 ppb at Mont Belvieu. Aircraft measured a peak concentration of 211 ppb that day.

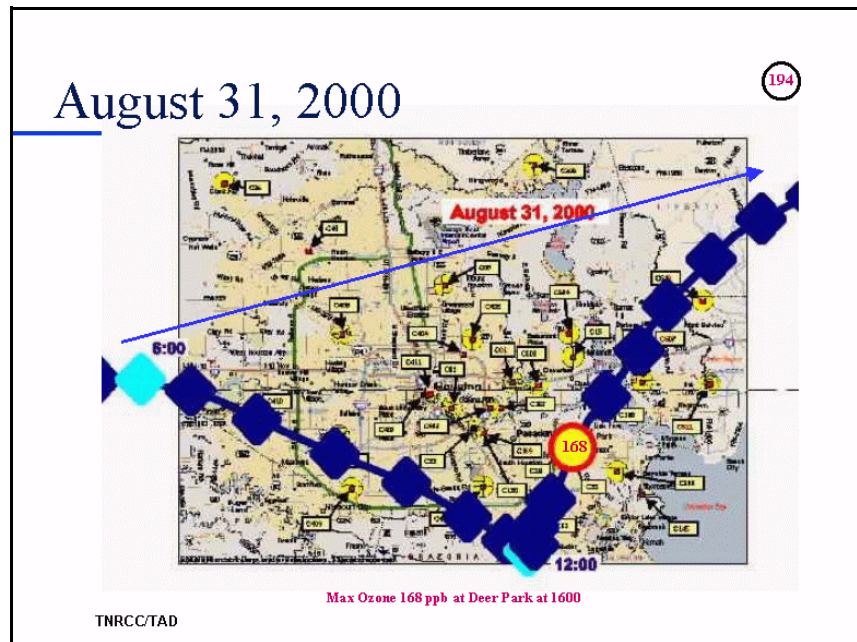


On August 30, the morning winds came from the west and northwest, and then shifted to the south with the sea breeze about noontime. Peak surface ozone on August 30th was 199 ppb measured at La Porte, but aircraft measurements indicated 220 ppb of ozone.

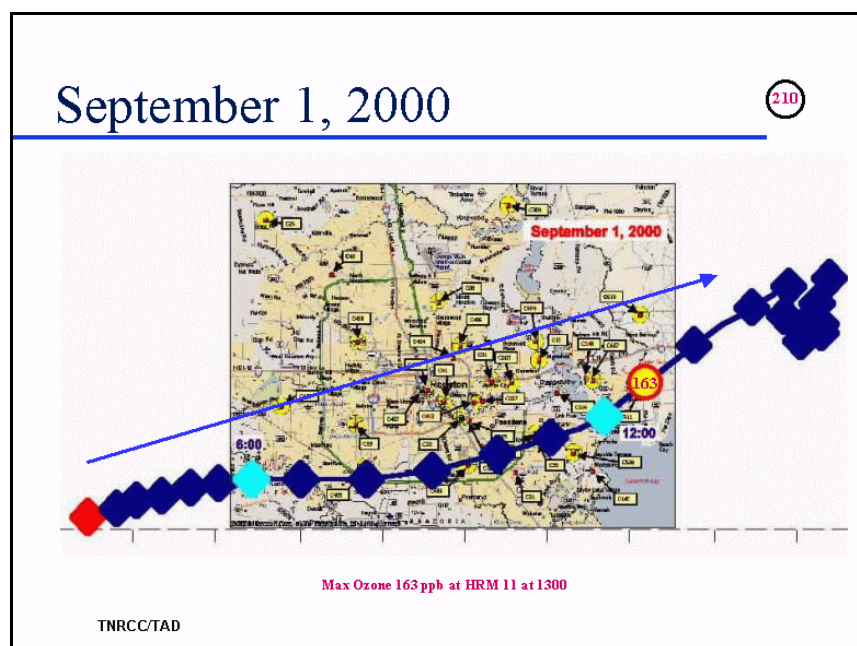


Aug 31st and Sept 1st, 2000

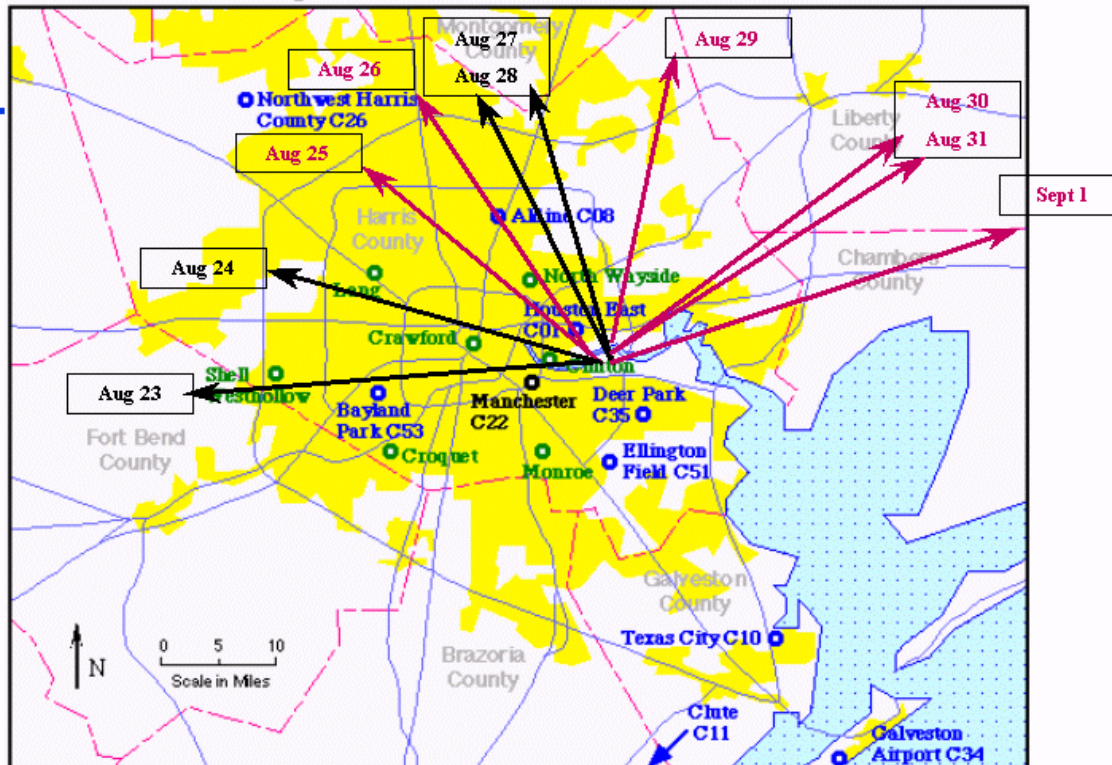
On August 31st, morning winds came from the northwest, and then shifted to the southwest at noontime. The peak surface ozone was 168 ppb at Deer Park, but aircraft measured 194 ppb that afternoon.



On September 1, 2000, the surface winds were fairly persistent, coming from the west-southwest all day. Peak surface ozone was 163 ppb at Baytown, but aircraft measurements indicated concentrations of 210 ppb downwind of the city.



Daily Wind Patterns During TexAQS 2000



TNRCC/TAD

The figure above shows the orderly daily clockwise progression in the direction of the surface transport winds during the August 23 - Sept 1, 2000 modeling period. This 10-day period includes both weekday and weekend ozone events and captures a suite of wind directions, with daily ozone peaks measured in different areas reflecting the net wind vector each day.

Phase I Modeling

It is clear that the August 23-September 1, 2000 period includes not only a ‘classic’ ozone episode, with flow reversal and numerous exceedances but also an orderly change in the daily net transport patterns representing a suite of different wind directions and source alignments. Combined with the extraordinary amount of meteorological and precursor data collected during the TexAQS study period, this single episode provides a representative set of ozone event types, and provides enough data to validate inputs and verify model performance.

Phase II Modeling

As noted earlier, during Phase II of the Mid Course Review, the August 23 - September 1, episode will likely be extended. The August 19-22 period includes another “classic” sea breeze event, as well as additional gas chromatograph data that will assist in validating VOC concentrations during the period. The September 2-6 period has northerly winds, which carry the urban plume to the southeast and south of the city. As a result, this period includes coastal exceedances as well as a particularly well defined plume stretching southwest of the city on September 6th.